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Symmetry and symmetry breaking during crystal growth

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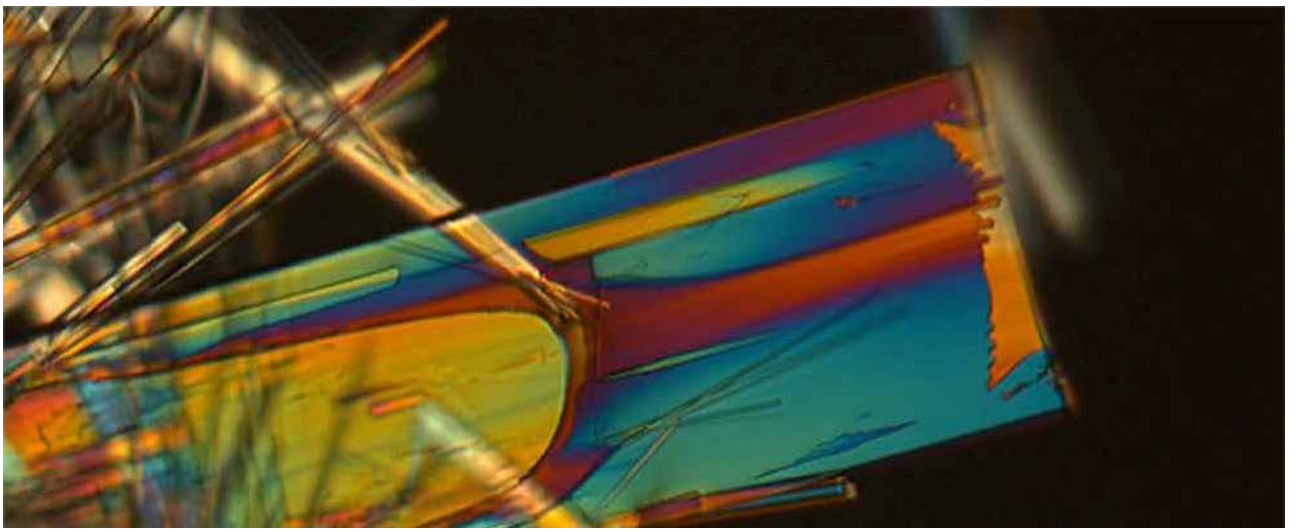
Two cases of symmetry and its breaking will be discussed in the context of crystal growth: chirality and surfaces. Chiral symmetry is a particularly interesting form of symmetry in crystal growth that may even be directly related to the homochirality that is found in Nature. About 10% of the chiral compounds crystallize as so-called racemic conglomerates, i.e. as separate crystals with only left or only right-handed molecules. The first experiments of Pasteur on a tartaric acid salt were an example of this. When crystallizing such compounds, one would expect a (symmetric) 50:50 mixture of both types of crystals, but often this is not the case. We will discuss (1) the chiral symmetry breaking in such systems [1], (2) the formation of epitaxial conglomerates that partially hide the true symmetry and (3) a phase transition from a racemic crystal (with both left- and right-handed molecules in the unit cell) to a racemic conglomerate. X-ray diffraction is often insufficient to fully characterize such systems, and solid-state NMR and computer simulations yield important additional insights. The symmetry of a bulk crystal is by definition broken at its surface, and this can manifest itself in different ways. Muscovite mica, as an example, can be made extremely flat by cleaving and therefore the bulk glide plane symmetry can be lost at the surface [2]. Charge neutrality dictates the distribution of the ions at the surface of mica and seems to be determined by local variations in the Al/Si ratio that are invisible for X-ray diffraction. By isomorphous replacement of the topmost K ions, mica can be functionalized to specifically react with other compounds.

[1] *W.L. Noorduin, E. Vlieg, R.M. Kellogg et al., Angew. Chem. Int. Ed., 2009, 48, 9600,* ***[2]*** *W. de Poel, G.S. Pintea, J. Drnec et al., Surface Sci., 2014, 619, 19*



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